U.S. ATLAS 04-5

Draft 7.4 December 27, 2004

U.S. ATLAS Research Program Management Plan

Physics & Computing is to be understood as S&C in PEQ, host lab and university vs BNL and Columbia for 20 years! Do it generically, allow Lab person to be RPM, can this be made more generic, not specific to current appointment?

Approved September 2004

SUBMISSION AND APPROVALS

This Management Plan defines the organization, systems and relevant interfaces for the U.S. Collaboration's participation in the operation of the ATLAS detector at the Large Hadron Collider (LHC) at the European Laboratory for Particle Physics (CERN), and in the planned physics investigations enabled by the detector. This management plan covers both pre-operations, operations, and detector maintenance and R&D (henceforth referred to collectively as "M&O") and software and computing efforts required for successful U.S. participation in the research program. The U.S. role in the operation of the ATLAS detector is funded jointly by the U.S. Department of Energy and the National Science Foundation. This document is intended to meet the expectation for management plans addressing pre-operations, operations, detector R&D and software & computing discussed in Reference 1 and Appendix 1 (DOE/NSF MOU and BNL Host Lab Letter).

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APPENDICES

LIST OF ABBREVIATIONS

ACWP	Actual Cost of Work Performed
ALD	BNL Associate Laboratory Director for High Energy and Nuclear Physics
APM	Associate Program Manager for Physics and Computing
AY	At Year (referring to a dollar value)
BCP	Baseline Change Proposal
BCWP	Budgeted Cost of Work Performed
BCWS	Budged Cost of Work Scheduled
BAO	Brookhaven Area Office
BNL	Brookhaven National Laboratory
CB	ATLAS Collaboration Board
CCB	Change Control Board
CDD	CERN Drawing Directory
CERN	European Laboratory for Particle Physics
CH	Chicago Operations Office
CMB	Computing Management Board
COB	Computing Oversight Board
C-RRB	Computing Resources Review Board
CY	Calendar Year
DOE	Department of Energy
DRPM	Deputy Research Program Manager
EC	Executive Committee
EDIA	Engineering Design, Inspection and Assembly
EDMS	Engineering Data Management System
EPM	Executive Program Manager for Physics and Computing
ES&H	Environmental Safety and Health
GriPhyN	GRId PHYsics Network (NSF Funded)
HEP	DOE Headquarters Office of High Energy Physics
IB	Institutional Board
ICB	International Computing Board
IMOU	Institutional Memorandum of Understanding (between U.S. ATLAS Research Program Office and an Institution)
IPA	Intergovernmental Personnel Appointment
IT	Information Technology
iVGDL	International Virtual Data Grid Laboratory (NSF Funded)
JOG	Joint Oversight Group
L2	WBS Level 2, e.g. 2.2
LCG	Large Hadron Collider Computing Grid Project
LHC	Large Hadron Collider
LHCC	CERN LHC Committee
M&O	Maintenance and Operations
MEG	M&O Evaluation Group
MOU	Memorandum of Understanding
MRE	Major Research Equipment
NSF	National Science Foundation
OSG	Open Science Grid
PBS	Product Breakdown Structure
PCAP	Physics and Computing Advisory Panel
PEB	Project Execution Board (for computing)
PO	U.S. ATLAS Project Office

POB	Project Oversight Board (for computing)
PPDG	Particle Physics Data Grid (DOE Funded)
QAP	Quality Assurance Plan
QAR	Quality Assurance Representative
R&D	Research and Development
RMCS	Research Management Control System
RPAP	Research Program Advisory Panel
RPM	U.S. ATLAS Research Program Manager
RPMP	Research Program Management Plan
RPO	Research Program Office
RPMS	Research Program Management System
RRB	ATLAS Resource Review Board
SC	DOE Office of Science
SC2	Software and Computing Committee (S&C)
SG	Scrutiny Group
SL	ATLAS System Leader
SM	U.S. ATLAS Subsystem Manager
SPMB	Software Project Management Board
TDR	Technical Design Report
TRT	Transition Radiation Tracker
WBS	Work Breakdown Structure

1 INTRODUCTION

1.1 The U.S. ATLAS Research Program and the Transition from the U.S. ATLAS Construction Project

1.1.1 Overview of the Research Program Management Plan

The U.S. Department of Energy and National Science Foundation are supporting the U.S. involvement in the two large detectors for the CERN Large Hadron Collider (LHC), ATLAS and CMS, through the fabrication of equipment and systems for those detectors as well as the U.S. involvement in the ensuing Research Program. The U.S. ATLAS Program thus includes the U.S. ATLAS Construction Project and the U.S. ATLAS Research Program. The U.S. ATLAS Construction (?) Project, the fabrication, delivery and installation of detector components for the initial ATLAS detector by U.S. institutions, is well underway and is managed according to the U.S. ATLAS Construction Project Management Plan (Reference 2, USATLAS 99-20), originally approved in March 1998.

The DOE and NSF have chosen to treat the totality of activities necessary for the U.S. to participate in the LHC as a single program that includes construction and subsequent research efforts for U.S. ATLAS, U.S. CMS and the U.S. LHC Accelerator. The management structures, roles, and responsibilities will be described in individual research program management plans such as this document, addressing both M&O and Software & Computing. The U.S. LHC Construction (?) Project Execution Plan (PEP) (Reference 2) will continue to define the management, execution and oversight arrangements for the U.S. ATLAS Detector Construction Project until its completion.

Comment [JW1]: Mention CERN RRB (p. 10, 11)

Since the U.S. work on the ATLAS Experiment is funded by both DOE and NSF, a Joint Oversight Group formed by the two agencies performs periodic reviews and assesses technical, schedule and cost performance. The specific responsibilities of the JOG are addressed in a Memorandum of Understanding between the DOE and the NSF on U.S. Participation in the LHC Program (Reference 1). Add new RPEP

The International Agreement Concerning Scientific and Technical Cooperation on Large Hadron Collider Activities of December 8, 1997, defines the U.S. responsibilities common to all parts of the LHC Program. The Experiments Protocol Concerning Scientific and Technical Cooperation on the Large Hadron Collider ATLAS and CMS Detectors of December 19, 1997, describes DOE and NSF responsibilities for the detectors. Finally, there are Memoranda of Understanding between nations participating in the LHC experiments and CERN, describing the responsibilities of all participants in these experiments. The Memorandum of Understanding (MOU) for Maintenance and Operation of the Detector between The European Organization for Nuclear Research (CERN) and the Funding Agencies of the Collaboration governing M&O of the experiment defines the roles, responsibilities and obligations of the U.S. ATLAS institutions during the operation and maintenance phases of the experiment (CERN-RRB-2002-035).

In addition to the ATLAS MOU for M&O agreement on pre-operations and operations, there will also be an ATLAS Memorandum of Understanding between CERN and the ATLAS funding agencies governing the Software & Computing (S&C) aspects of the LHC Research Program. The Software and Computing MOU has been preceded by Software Agreements covering responsibilities for software development before the final MOU is defined. A statement about the Holy G word?

The U.S. ATLAS Research Program consists of three major components: 1) pre-operations, operations, detector maintenance and education/outreach (collectively referred to as M&O); 2) Physics and Computing (including software and related hardware; and 3) Upgrade R&D. The grouping of these three components follows the guidance of the Joint Oversight Group of the DOE and NSF (JOG) (see

Appendix 1 and subsequent funding guidance). Note that detector R&D is usually considered as part of M&O, but if you wish to define it this way, that's fine too.

The present document describes an organization and management plan for U.S. responsibilities during the pre-operations and research program of the ATLAS experiment. This program begins with pre-operations of completed components of the detector before the turn-on of the initial detector, now expected in CY 2007. It includes U.S. responsibilities for M&O of the detector and its subsystems and for Upgrade R&D for the detector which will be proposed and approved as required. This management plan anticipates that the upgrades, when proposed and approved, will be managed within the Research Program and an amendment will be made at that time. The Research Program of the ATLAS experiment will last for an indefinite time after initial turn-on and is expected to extend for at least 20 years, as established in the "International Cooperation Agreement" between CERN and the U.S. (Appendix A of Reference 2).

The U.S. ATLAS Collaboration presently consists of scientists and engineers from 31 U.S. universities and three national laboratories, and is part of the international ATLAS Collaboration that has overall responsibility for the ATLAS detector. U.S. institutions admitted to the ATLAS Experiment (Appendix 3) are automatically included in the U.S. ATLAS organization. The Host Laboratory for the U.S. ATLAS Research Program will be Brookhaven National Laboratory, where the Research Program Office will be located (see Appendix 1 – Letter to Marburger).

Comment [JW2]: Refer to App. 2 first

During this next 20-year period, physicists on U.S. ATLAS will be involved and committed to the exploitation of the ATLAS detector for the advancement of knowledge of particle physics. However, funding for physicists at U.S. ATLAS institutions and the conduct of their research activities will not be managed under this Research Program Management Plan. It is assumed that salaries and all expenses of scientific personnel for U.S. ATLAS will be provided via the base program, and fulfill the needs and challenges of U.S. operational responsibilities on the ATLAS detector to the DOE and NSF program managers. We expect U.S. physicists to continue to be leading contributors to the ATLAS physics analysis program. MOUs will be written between each institution and the U.S. ATLAS Research Program Office that will list all physicists working on data analysis as well as those contributing to the Research Program of M&O, support, computing and upgrade R&D.

1.1.2 Transition from the U.S. ATLAS Construction Project to the U.S. ATLAS Research Program

There is a management structure now in place as given in the Revised U.S. ATLAS Construction Project Management Plan (Reference 2). The U.S. ATLAS Construction Project Management Plan and the U.S. LHC Construction PEP define the construction project line management oversight and reporting requirements, from the U.S. ATLAS Project Manager through the U.S. LHC Project Office to (?) the U.S. LHC Program Office and JOG.

The provisions of this Research Program Management Plan will become effective as soon as it is approved, with the U.S. ATLAS Project Manager functioning also as the Research Program Manager. As of September 1, 2004, a full time Research Program Manager has been appointed, chosen by the host laboratory. A Deputy Research Program Manager has also been appointed. (?) I don't follow?

The U.S. ATLAS Research Program will manage the continuing resources needed to maintain the computer professionals and equipment that will assure that U.S. physicists will have sufficient capability to contribute strongly to the physics analysis.

1.2 Description of Detector

The ATLAS detector consists of an inner tracking system with silicon pixels, silicon strips and a transition radiation tracker (TRT); a liquid argon electromagnetic and a forward calorimeter; a

scintillating tile hadronic calorimeter; a muon spectrometer; and a trigger and data acquisition system. There is a superconducting solenoid and superconducting toroid magnets to provide charge and momentum measurements of charged-particle products of the collisions. U.S. groups are involved in almost all of these components of the ATLAS detector, which is being built by a large international collaboration. Detailed descriptions of all these systems are given in the Technical Design Reports (TDRs), which have been reviewed by the CERN LHC-Committee (LHCC) and approved by the Director General of CERN.

2 ATLAS OBJECTIVES

2.1 Scientific Objectives

The fundamental unanswered problem of elementary particle physics relates to the understanding of the mechanism that generates the masses of the W and Z gauge bosons and of quarks and leptons. To attack this problem requires an experiment that can examine a large rate of particle collisions at very high energy. The LHC will collide protons against protons every 25 ns at a center-of-mass energy of 14 TeV and a luminosity of 10^{34} cm^{-2} s^{-1}. It will likely take one or two years of running to reach the full design luminosity.

The detector is designed to be capable of reconstructing a variety of interesting final states. It must be able to fully utilize the high luminosity so that detailed studies of rare phenomena can be carried out. While the primary goal of the experiment is to determine the mechanism of electroweak symmetry breaking via the detection of Higgs bosons, supersymmetric particles or possible structure in the WW scattering amplitude, the new energy regime will also offer the opportunity to probe quark substructure and to search for new phenomena. The detector must be sufficiently versatile to detect and identify the final state products in such processes. In particular, it must be capable of reconstructing the momenta and directions of quarks (hadronic jets, tagged by their flavors where possible), electrons, muons, ? leptons, and photons, and be sensitive to energy carried off by weakly interacting particles such as neutrinos or supersymmetric particles that cannot be detected directly. The ATLAS detector has been designed to have all these capabilities.

2.2 Technical Objectives

The ATLAS detector is designed to perform a comprehensive study of the source of electroweak symmetry breaking, as well as to search for a host of other phenomena that may be observed at these new energies. It is expected to operate for twenty or more years at the CERN LHC, observing collisions of protons, and recording more than 10^9 events per year. The critical objectives needed to achieve these goals are:

- ? Excellent photon and electron identification capability, as well as measurement of their energies and directions.
- ? Efficient charged-particle track reconstruction and good momentum resolution.
- ? Excellent muon identification capability and momentum resolution.
- ? Well-understood trigger system to go from a 1 GHz interaction rate to ~100 Hz readout rate, with minimal loss of interesting signal.
- ? Excellent coverage in calorimetry to provide accurate measurement of the directions and energies of quarks and gluons, and excellent reconstruction of missing transverse momentum.
- ? Efficient tagging of b-decays and b-jets.

The detector completed as part completion of the Construction Project will be extremely versatile and will meet many (?) of these requirements. Reliable operation of the detector will also be required to meet the

physics objectives. Appropriate attention must be paid to calibration of separate elements, selection and implementation of triggers, and maintenance and reliability, among other requirements.

Upgrades to the initial detector will be needed to meet objectives that are understood now but could not be met with the initial detector because of cost and/or schedule constraints. In addition, new capabilities will be identified that will be needed or highly desirable as a result of the understanding of both the physics requirements and detector capabilities that will emerge from initial operating experience. A major upgrade is envisaged in the next decade, when plans to increase the luminosity of the LHC by a factor of ten solidify. All upgrades will have a well-defined approval procedure within ATLAS, as well as outside peer and agency review within the U.S. for the portions of the detector funded by the U.S.

2.3 Cost and Schedule Objectives

ATLAS has made an estimate of M&O costs through a committee established by the Collaboration Board. The committee included representatives of ATLAS Management and of each detector system. The resulting report titled "ATLAS M&O Working Group Conclusions and Recommendations" was accepted by the Collaboration Board and has been reviewed by CERN management.

The ATLAS M&O committee estimated costs by calendar year, starting in 2002 and continuing into the data taking period starting in 2007. In August and (or?) September of each year, starting in 2001, a Scrutiny Group (SG), representing the RRB, reviews the ATLAS M&O estimates. These estimates include category A, B and C items. Category A represents common responsibilities shared by all funding agencies, according to the number of scientific authors; category B represents costs for a particular system in ATLAS, and is shared by the institutes with responsibility for that system, based on their investment in the initial detector; and Category C represents the responsibility of the host lab (CERN).

Detailed schedules will eventually be developed through the ATLAS Technical Coordination organization. First collisions at the LHC are scheduled in FY 2007. The lifetime of the experiment will be determined through a variety of considerations, including the richness of emerging physics, availability of funds, and the construction of new facilities in the field. Nevertheless, it is expected that the experiment will take data for a minimum of 20 years.

An MOU for Computing and Software components of the Research Program is being drafted both for contributions to the LHC Computing Grid Project at CERN (LCG) as well as for computing contributions to the experiments. Point to something! (reference) Ask Shank for another sentence.

3 ATLAS ORGANIZATION

3.1 The International ATLAS Experiment and its Management

The large general-purpose LHC experiments rank among the most ambitious and challenging technical undertakings ever proposed by the international scientific community. The inter-regional collaborations assembled to design, implement and execute these experiments face unprecedented sociological challenges in marshalling their enormous, yet highly decentralized, human and economic resources. The overall ATLAS approach to this challenge is to base most of the ATLAS governance on the collaborating institutions rather than on any national blocks. Thus, the principal organizational entity in ATLAS is the Collaboration Board (CB), consisting of one voting representative from each collaborating institution, regardless of size or national origin.

The CB is the entity within ATLAS that must ratify all policy and technical decisions, and all appointments to official ATLAS positions. It is chaired by an elected Chairperson who serves for a non-

renewable two-year term. The Deputy Chairperson, elected in the middle of the Chairperson's term, succeeds the Chairperson at the end of the term. The CB Chairperson appoints (and the CB ratifies) a smaller advisory group that can consult between ATLAS collaboration meetings.

Executive responsibility within ATLAS is carried by the Spokesperson who is elected by the CB for renewable three-year term. The Spokesperson is empowered to nominate one or two deputies to serve for the duration of the Spokesperson's term in office. The Spokesperson represents the ATLAS Collaboration in all its external activities.

The ATLAS central management team presently includes Technical and Resource Coordinators, both CERN staff members whose appointments require CERN management approval. The Technical Coordinator has overall responsibility for technical aspects of detector construction. This includes responsibility for integration of ATLAS subsystems and for coordination with the CERN infrastructure, including the installation of the experiment at surface and underground areas. The Resource Coordinator is responsible for the budget and human resources, including securing Common Fund resources, and negotiating the MOUs with funding agencies. It is likely that the management will evolve to meet the needs of the Research Program, for instance, with the addition of another Physics Coordinator for overseeing (?) data analysis and research publications. Computing and upgrades will also become more important with time. Until the initial detector is complete and operational, the Technical and Resource Coordinators will address issues of M&O in coordination with the completion of detector construction.

Already have a PC?!

The ATLAS Spokesperson presently chairs an Executive Board (EB), consisting of representatives from the major high-level detector subsystems and the Technical, Resource and Computing Coordinators, Physics Coordinator and Electronics Coordinator and two at-large members. Computing Coordination involves the Computing Coordinator and the Software Project Leader. The Executive Board directs the execution of the ATLAS experiment according to the policies established by the Collaboration Board. Additional evolution of the Executive Board is expected to reflect the emphasis on physics during the Research Program. The overall structure of the ATLAS organization may also change considerably at that time.

There is also a Technical Management Board chaired by the Technical Coordinator that meets weekly with the Spokesperson, Deputy Spokesperson, Resource Coordinator, and the Activity (?) Where defined? Physics/Software Facilities? Managers within Technical Coordination. Experts, including the physicist and engineer responsible for each of the ATLAS Systems, are called into the meetings as needed. This Board is also likely to evolve in the Research Program. For example, two Commissioning Coordinators have recently been elected and attend part of the EB meeting.

Comment [JW3]: next three paragraphs ?

Each ATLAS subsystem has a Project Leader responsible for ensuring that the design and construction of the corresponding subsystem is carried out on schedule, within the cost ceiling, and in a way that guarantees the required performance and reliability. Each major ATLAS subsystem is overseen by a technically-oriented Steering Group, with expertise in all the relevant technical areas. A Physics Coordinator leads the different physics analysis groups. The focus on data analysis is expected to evolve once the detector turns on.

It is understood that the U.S. ATLAS management must operate within the regulations imposed by the U.S. funding agencies, the funding appropriated by the U.S. Congress, and the terms of the U.S.-CERN Protocol on LHC Experiments. Subject to these limitations, it is expected that the U.S. ATLAS (management implements all decisions taken by the ATLAS Resource Review Board (RRB) and the Collaboration Board. The RRB comprises representatives from all ATLAS funding agencies and the

managements of CERN and the ATLAS Collaboration.)? The U.S. has DOE and NSF representatives. The RRB meets twice per year, usually in April and October. With regard to oversight of the ATLAS M&O costs, the RRB is assisted by a CERN Scrutiny Group, the role of which is to analyze critically the M&O reports and estimates made by the Collaboration, refine estimates in consultation with the Collaboration and advise the RRB on any course of action. The Scrutiny Group is set-up to include representatives from Member States and Non-Member states, including a U.S. representative.

As far as experiment operations and upgrades are concerned, decisions by the ATLAS Executive Board (EB) should also be adopted directly or, if not compatible with the U.S. operating procedures, adapted so as to match the EB decision as closely as possible. In the latter case, ATLAS management and the U.S. LHC Program Office should be consulted and informed about the detailed nature of U.S. implementation.

ATLAS has adopted procedures for quality control and change requests valid for all Collaboration partners. For example, a Product Breakdown Structure (PBS/WBS) structure has been established and a global Engineering Data Management System (EDMS) used to manage documents pertaining to ATLAS Technical Coordination, the ATLAS Detector, General Facilities, Assembly and Test Areas and Offline Computing. A CERN Drawing Directory (CDD) is used to manage all drawings. It is understood that the U.S. institutions will use these management procedures and tools in the same way as other ATLAS institutions. Similar structures are expected to be used for any future upgrade projects for the ATLAS detector.

3.1.1 ATLAS Computing and Physics Management

An organization is in place in the ATLAS Collaboration for the development of computing and analysis capabilities. In this section, we give a brief description of the main elements

The organization of ATLAS Computing is illustrated in the chart found at the URL:
http://atlas.web.cern.ch/Atlas/GROUPS/SOFTWARE/OO/Organization/

The top level of management of ATLAS Computing which reports to the ATLAS EB, consists of the Computing Coordinator and the Software Project Leader. These positions have three-year terms, and are filled by the Spokesperson following a nomination process and subsequent approval by the Collaboration Board. The highest level of oversight for computing is left to the Computing Oversight Board (COB), which consists of the ATLAS Spokesperson, Deputy Spokesperson, Physics Coordinator, Computing Coordinator and Software Project Manager. The Computing Coordinator is advised by the International Computing Board (ICB). The International Computing Board is chaired by a member nominated and elected by the Board, with the approval of the Spokesperson. The ICB consists of one member from each funding agency (?) associated with resources employed by ATLAS Computing, and has the purpose of refining and approving the computing model, gathering and assigning resources and acting as an interface between ATLAS Computing and the national funding agencies. Ultimately, computing resources specific to ATLAS are reviewed in the ATLAS Resources Review Board (RRB).

A Computing Management Board (CMB) reports to ehe Computing Coordinator. Will this always be a multicolored document (should not assume)? I would avoid “yellow” even though it is not included here. The CMB consists of seven members who act as liaisons in several domains that affect ATLAS Computing: the ICB Chair, a liaison for the Trigger and Data Acquisition subsystem, a liaison to Physics Coordination, an Event-Data Store Coordinator and general Data Management Coordinator, the Grid and Data Challenge Coordinator and the Planning and Resources Organizer. The Software Project Manager works with the Architecture Team (A-Team) to build, document, and maintain the primary software services required by ATLAS Computing. Subsystem-specific software, such as detector simulation and reconstruction, are the responsibilities of the detector subsystems, but require liaisons from each of the

subsystems to the Software Project Manager. In addition to the subsystem-specific software, there are areas that are coordinated by the Software Project Manager: Simulation, Core Services, Infrastructure (e.g., code management), Calibration/Alignment, Event Selection and a liaison to the LHC Computing Grid Project (LCG). Each of these areas has a person reporting to the Software Project Manager. Taken together, the responsible parties form the Software Project Management Board (SPMB).

A second area of computing that U.S. ATLAS participates in is the LHC Computing Grid Project (LCG). The LCG is a project that is central to all four LHC experiments and is intended to provide the computing infrastructure required in common to LHC via the use of computational grids. The LCG organization structure can be found at the following URL: http://lcg.web.cern.ch/LCG/LCGProjectStructure.htm

Resources specific to LCG are reviewed by the Computing Resources Review Board (C-RRB). High level oversight of the LCG is undertaken by the Project Oversight Board (POB), which consists of one member from each nation contributing significant resources to LHC Computing, the LCG Project Manager, a representative of CERN management, the Director of the Information Technology Division (IT) at CERN, a recording secretary, and the computing coordinator from each of the four experiments. The PEB (POB?) meets three times a year. Operations of the LCG are managed by the Project Execution Board (PEB), which is managed by the LCG project manager, appointed by the CERN Director General. The PEB consists of distinct work areas, such as common application support, CERN computing infrastructure, grid middleware etc., each with its own sub-manager. All managers of work areas covered by LCG are members of the PEB and report to the LCG Project Manager. The PEB is responsible for executing the computing requirements established by the Software and Computing Committee (SC2). In addition to establishing the computing requirements, the SC2 meets quarterly and tracks milestones and progress of the LCG. (SC2 connots of ?)

3.2 Membership of the U.S. ATLAS Collaboration

The U.S. ATLAS Collaboration consists of physicists and engineers from U.S. institutions collaborating on the ATLAS experiment at the CERN LHC. Appendix 3 shows a list of the participating institutions. Individuals from these institutions share responsibility for the construction and execution of the experiment with collaborators from the international high-energy physics community outside the U.S. Current institutional responsibilities are shown in Appendix 4. New U.S. institutions formally voted in as members of ATLAS become automatic members of U.S. ATLAS.

3.3 Management Organization of the U.S. ATLAS Research Program

A Research Program Management structure has been established to facilitate interactions with U.S. funding agencies and for effective management of U.S. ATLAS activities and resources. This structure is supported by the Research Program Offices located at BNL and Columbia and is in accord with the letter (see Appendix 2) from the Joint Oversight Group to the BNL Director requesting that a U.S. ATLAS Research Program Manager and Deputy Research Program Manager be appointed. Appendix 5 shows the organization chart for the U.S. ATLAS Research Program. This organization is headed by a U.S. ATLAS Research Program Manager and Deputy. Reporting directly to the Research Program Manager are a Coordinator for Education/Outreach, Managers for each subsystem, an Upgrade R&D Manager and the two managers for Physics and Computing. The organization also includes an Institutional Board with representation from each collaborating institution, and an Executive Committee. The responsibilities of each are described below. U.S. ATLAS planning and management is being done in close cooperation with the overall ATLAS management team. The U.S. Subsystem Managers interact closely with the corresponding overall ATLAS Project Leaders, and there is also close cooperation between Physics and Computing Managers, and the U.S. ATLAS Research Program Manager and Deputy maintain close contact with the ATLAS Spokesperson, Deputy Spokespersons, and the Technical and Resource Coordinators.

I assume BNL is host for foreseeable future, but is Columbia guaranteed 20 years? Also, isn't it prejudicial to assume that RPM/DRPM will be always similar (Columbia/BNL)? What if RPM is from BNL?

3.3.1 U.S. ATLAS Research Program Manager and Deputy (what?)

The U.S. ATLAS Research Program Manager (RPM) has the responsibility of providing programmatic coordination and management for the U.S. ATLAS Research Program. The RPM represents the U.S. ATLAS Collaboration in interactions with overall ATLAS management, CERN, DOE, NSF, the universities and national laboratories involved and BNL, the Host Laboratory on all issues concerning the Research Program. The RPM is appointed by the Director of BNL with concurrence of the Joint Oversight Group (JOG) of DOE and NSF and recommendation from the U.S. ATLAS Institutional Board. The RPM serves renewable terms of five years and reports to the BNL Director (or an appointed representative). The RPM is advised by an Executive Committee, as described below. A U.S. ATLAS Deputy (univ or lab?) Research Program Manager (DRPM) is also appointed by the Director of BNL and shares responsibilities with the RPM. The DRPM may represent the RPM as needed. With respect to technical, budgetary, and managerial issues, the Deputy Research Program Manager, the Subsystem Managers, the Upgrade R&D Manager, and the Physics/Computing Manager, augmented by the Convener of the Institutional Board, act as a subcommittee of the Executive Committee to provide advice to the RPM. Consultation with this subcommittee is part of the process by which the RPM makes important technical and managerial decisions. An example of this kind of managerial decision would be a modification of institutional responsibilities.

The responsibilities of the U.S. ATLAS Research Program Manager include:

1. Appointing, after consultation with the U.S. ATLAS Collaboration and approval of the IB, the U.S. Subsystem Managers, the Upgrade R&D Manager, and the Physics/Computing Managers. M&O?
2. Preparing the yearly funding requests to DOE and NSF for the anticipated U.S. ATLAS Research Program.
3. Recommending to DOE and NSF the institution-by-institution funding allocations to support the U.S. ATLAS Research Program. These recommendations will be made with the advice of the U.S ATLAS Executive Committee.
4. Approving budgets and allocating funds in consultation with the SMs and with the EPM for Physics and Computing and Management Reserve, in accord with the Change Control Process in Section 7.4.
5. Establishing, with the support of BNL and Columbia (?) management, a U.S. ATLAS Research Program Office offering appropriate support services.
6. Working with BNL management and the U.S. LHC Research Program Office to set up and respond to other mechanisms needed to carry out oversight responsibility.
7. Keeping the BNL Director or representative and the U.S. LHC Program Office well informed on progress of the U.S. ATLAS Research Program, and reporting promptly any problems whose solutions may benefit from joint efforts of the RPM, BNL management and the U.S. LHC Research Program Office.
8. Interacting with CERN and ATLAS management on issues affecting resource allocation and availability, and preparation of international MOUs defining U.S. responsibilities and signing these MOUs.
9. Advising the DOE and NSF representatives at the ATLAS Resource Review Board meetings.
10. Negotiating and signing the U.S. Institutional MOUs (IMOU) representing agreements between the U.S. ATLAS Research Program Office and the U.S. ATLAS collaborating institutions specifying responsibilities and resources available on an institution-by-institution basis.
11. Reporting periodically on U.S. ATLAS operations and upgrade status and other issues to the U.S. LHC RPO and the Joint Oversight Group. What about C&S?

12. Representing the U.S. ATLAS collaboration in discussions with funding agencies and planning bodies, including the APS Division of Particles and Fields and HEPAP.
13. Conducting, at least twice a year, meetings with the U.S. ATLAS Executive Committee to discuss budget planning, milestones, and other U.S. ATLAS management issues.
14. Making periodic reports to the U.S. ATLAS Institutional Board to ensure that the Collaboration is fully informed about important issues.
15. Overseeing ES&H and QA/QC Management for the U.S. institutions.

Management structure at ATLAS does not seem to parallel that of funding allocations: S&C + M&O (including R&D). Think on it?

The channels for funding, reporting, and transmission of MOUs are shown in Appendix 6. Clarify this sentence. Are you referring to the Base Program + Research Program (US LHC)? Make sure you're consistent with new RPEP. DOE Research Program funding will be a mixture of grants and Research Contracts through BNL. NSF funding will be carried out via subcontracts through Columbia University (?). What does this mean? From RP funds? Elaborate! Further details on the titles and roles of participants in the governance of the U.S. ATLAS Collaboration are given below.

3.3.2 Institutional Board

The U.S. ATLAS Collaboration has an Institutional Board (IB) with one member from each collaborating institution and a Convener elected by the Board. The Convener serves for a three-year renewable term. The IB will normally meet at least once per year. Under normal circumstances the meetings are open to the Collaboration, although closed meetings may be called by the Convener to discuss detailed or difficult issues. Only IB members or their designates can vote on any question.

The IB members represent the interests of their institutions, and serve as contacts between the U.S. ATLAS management structure and the collaborators from their institutions, who select their respective representatives.

The Institutional Board deals with general issues of policy affecting the U.S. ATLAS Collaboration. For example, the IB discusses applications of new institutions to join ATLAS and forward the conclusion to the U.S. ATLAS Research Program Manager. As chairman of this board, the Convener organizes meetings on issues of general interest and speaks for U.S. ATLAS on issues that affect the Collaboration (to whom?). The Convener also prepares nominations of ad hoc committees to run elections for which the IB is responsible, including those for additional subsystem members of the Executive Committee and for IB Convener. The committees must be approved by the IB. The Convener recommends to the Institutional Board the establishment of any standing committees to deal with Collaboration-wide issues if the need arises. A Subcommittee of the Institutional Board also provides its recommendation on the appointment of the Research Program Manager and Deputy? to the BNL Director, and to the U.S. LHC Research Program Office.

3.3.3 Executive Committee

The Executive Committee is chaired by and advises the Research Program Manager on global and policy issues affecting the U.S. ATLAS Collaboration or the U.S. ATLAS Research Program. Its membership is constituted from the following:

- The Research Program Manager
- The Project Manager
- The Deputy Research Program Manager

? The Subsystem Managers and the Physics and Computing Managers
? The Subsystem Representatives from each subsystem in which U.S. groups play a major role with their number being specified in parentheses below:
  * Semiconductor tracker (1)
  * TRT (1)
  * Liquid argon calorimeter and forward calorimeter (2)
  * Tile calorimeter (1)
  * Muon spectrometer (2)
  * Trigger/DAQ subsystems (1)
? The Education/Outreach Coordinator
? Physics, Software and Facilities (?) Managers
? The U.S. members of the overall ATLAS Executive Board
? The Convener of the Institutional Board
? Upgrade R&D Manager and
? Other members mandated by the Institutional Board

3.3.4 Education/Outreach Coordinator

The Education/Outreach Coordinator, appointed by the RPM, is expected to champion educational programs associated with ATLAS and with the U.S. member institutions, to report to the Executive Committee on these issues, and to act as liaison to DOE and NSF for educational activities. The intended audiences for these education activities are a) the general public, b) secondary school students, c) undergraduates, and d) primary and secondary school teachers.

3.3.5 Subsystem Managers

The Subsystem Managers (for WBS 3.1-3.10) nos 3.8, 3.9? are responsible for the technical, schedule, and cost aspects of the M&O for their subsystems. (They are appointed by the U.S. ATLAS Research Program Manager upon recommendation of the IB members whose institutions are involved in that subsystem.) They develop budgets for the institutions participating in their subsystems and serve on a subcommittee of the Executive Committee advising the RPM on technical, budgetary, and managerial issues relevant to the U.S. ATLAS Program. . not needed

3.3.6 Associate Program Manager for Physics and Computing

The Associate Program Manager for Physics and Computing (APM), appointed by the RPM with concurrence of the IB, is responsible for technical, managerial, political, and schedule aspects of broader external entities that overlap, include or impact on US ATLAS Computing and Physics program. Examples of such entities are the DOE and NSF, BNL, the LHC Computing Grid (LCG) project, the Open Science Grid (OSG), the Particle Physics Data Grid (PPDG), GriPhyN and the International Virtual Data Grid Laboratory (iVDGL).

The management responsibilities of the APM include:

1. Development of long-term strategies for funding the program.
2. Coordination of long-term computing strategies with US Funding agencies, other US organizations (US CMS, Regional centers, other sciences), International ATLAS and CERN.
3. Acting as liaison between the program and the ATLAS Computing management, in particular in matters with broader impact and long-range effect such as the grid computing efforts.
4. Act as a liaison between the program which one? and the LCG.
5. Act as a liaison between the program which one? Use U.S. ATLAS? and other relevant grid projects such as PPDG and iVDGL.

3.3.7 Executive Program Manager for Physics and Computing

The Executive Program Manager for Physics and Computing (EPM), appointed by the RPM with concurrence of the IB is responsible for the technical, schedule and cost aspects of U.S. ATLAS Computing, overseeing the work of the Level 2 Physics, Software and Facilities Managers. The EPM develops the budgets for the participating institutions.

Management responsibilities of the EPM include:

1. Establishing and maintaining the organization of the work breakdown structure and tracking based on the resources of the U.S. ATLAS Research Program Office U.S. ATLAS?; this includes the management of procurements, schedules, reporting, etc.
2. Developing the annual budget request for the RPM; the budget requests are reviewed by level 2 project managers and are approved by the RPM.
3. Acting as a liaison between U.S. ATLAS physics and computing efforts and the ATLAS Computing management on matters concerning the WBS, manpower and U.S. deliverables.
4. Appointing the Physics, Software and Facilities Managers with the concurrence of the RPM and the IB.
5. Providing coordination and management direction to the subprojects, including requirements for appropriate reporting and tracking, and responses to technical reviews.
6. Reviewing and recommending approval of memoranda of understanding (MOU) between CERN and the U.S. ATLAS Program concerning physics and computing.
7. Preparing change control requests within program change control protocols.
8. Establishing advisory committees where appropriate.
9. Providing reports and organizing reviews in conjunction with the U.S. LHC Research Program Office.
10. Reviewing and recommending approval of institutional memoranda of understanding (IMOU) between the Program which? Office and U.S. ATLAS institutions.

3.3.8 Physics Manager (PM)

The Physics Manager is a L2 Manager charged with providing leadership and assistance to members of U.S ATLAS involved in physics analysis. The PM is also responsible for providing support functions for physics related tasks for the U.S. ATLAS Collaboration and for fulfilling specific responsibilities negotiated with International ATLAS, such as support of certain event generators. The Physics Manager is appointed by the Executive Program Manager, with the approval of the RPM and the IB.

3.3.9 Software Manager

The Software Manager is a L2 manager and responsible for the technical, schedule, and cost aspects of U.S. work on ATLAS software, both maintenance activity and development of required new and upgraded software. The Software Manager develops the budgets for the institutions participating in work on software. The Software Manager is responsible for software support of a code repository at BNL and support of U.S. physicists in the use of ATLAS software. The Software Manager is appointed by the Executive Program Manager, with the approval of the RPM after consultation with the IB members whose institutions are involved in the software effort.

3.3.10 Facilities Manager

The Facilities Manager is a L2 manager responsible for the technical, schedule, and cost aspects of U.S. ATLAS computing facilities. The U.S. ATLAS Facilities Organization provides the support for analysis of data by U.S. ATLAS physicists and carries out specific computing tasks for the International ATLAS experiment per agreement between the two. The Facility Manager's responsibilities include Level 3 tasks involving the national Tier 1 computing center at Brookhaven National Laboratory; Tier 2 centers, of which there will be roughly 5 for U.S. ATLAS, production; implementation of grid software; and

optimizing use of resources. Level 3 Managers will be appointed by the Facilities Manager for each of these tasks. The Facilities Manager is appointed by the Executive Program Manager, with approval of the Research Program Manager and the IB.

3.3.11 Upgrade R&D Manager

The Upgrade R&D Manager is responsible for technical, schedule and cost aspects of U.S. ATLAS Upgrade R&D. This R&D is focused on developing detectors that will be able to be deployed in about 2015 if the plan to increase LHC luminosity to 10^{35} $cm^{-2}s^{-1}$ is proposed, approved and comes to fruition. A separate organization under the Upgrade R&D Manager may be required in the future.

3.3.12 Brookhaven National Laboratory (BNL) and Columbia University (?)

The DOE and NSF have assigned BNL management oversight responsibility for the U.S. ATLAS Research Program. The BNL Director has the responsibility to assure that the operations effort is being managed soundly, that technical responsibilities are executed in a timely way, that technical or financial problems, if any, are being identified and properly addressed, and that management organization is in place and functioning effectively. The BNL Director has delegated certain responsibilities and authorities to the Associate Laboratory Director for High Energy and Nuclear Physics. The Associate Laboratory Director is responsible for day-to-day management oversight of the Research Program and the U.S. ATLAS Research Program Manager reports to him/her. Specific responsibilities of the BNL Directorate include:

1. Upon recommendations of the U.S. ATLAS Collaboration, appointing the U.S. ATLAS Research Program Manager and Deputy? subject to the concurrence of the Joint Oversight Group;
2. Establishing an advisory structure external to the U.S. ATLAS Research Program for the purpose of monitoring both management and technical progress for all U.S. ATLAS activities;
3. Assuring that the Research Program Manager has adequate staff and support, and that U.S. ATLAS management systems are matched to the needs of the tasks;
4. Consulting regularly with the Research Program Manager to assure timely resolution of management challenges;
5. Concuring with any International Memoranda of Understanding specifying U.S. responsibilities for the U.S. ATLAS Research Program funded by DOE and NSF.
6. Concuring with the institutional Memoranda of Understanding for the U.S. ATLAS collaborating institutions that specify responsibilities and resources for each institution;
7. Ensuring that there is accurate and timely reporting to the U.S. LHC Research Program Office (?) manner.
8. Approving Baseline Change Proposals, as indicated in Section 7, which includes any use of Management Reserve.

Brookhaven National Laboratory has also been designated as the host laboratory for U.S. ATLAS. In this role, BNL will have the following responsibilities:

1. Staffing and operating the U.S. ATLAS Research Program Office (RPO);
2. Operating and upgrading as needed the U.S. ATLAS Tier 1 center for computing support;
3. Ensuring, that funding and facilities permit strong participation in physics analysis by U.S. ATLAS researchers.

The NSF Division of Physics has delegated financial accountability to Columbia University (?) inclusive of line management authority, responsibility and accountability for overall implementation of operations, and contract administration. The Director of Nevis Laboratory (?) is responsible for dispersal of NSF funds according to the allocations recommended by the U.S. ATLAS Research Program Manager and consistent with NSF policies. What about the U.S. LHC Program Office?

Try to make all this generic. If BNL closes, Columbia is sold…..)
Brookhaven and Columbia (?) are also collaborators in U.S. ATLAS with specific responsibilities for Physics and Computing, M&O and Upgrade R&D work, as well as full participation in physics analysis activities.

3.3.13 Research Program Advisory Panel (Jan 4-5 Panel?)

The Brookhaven Associate Laboratory Director for High Energy & Nuclear Physics (ALD) appoints the Research Program Advisory Panel (RPAP) consisting of individuals outside of the U.S. ATLAS Collaboration with expertise in technical areas relevant to the Research Program and the management of large projects. The RPAP assists the ALD in oversight responsibility for the work performed in the Research Program, including the operation of the detector, work on upgrades and computing, and advice on the rate of progress and adherence to the operations plan as it relates to cost, schedule and technical performance. The primary mechanism for performing this oversight role is through the Research Program Manager's periodic reviews of the U.S. ATLAS subsystems, followed by discussions among the attending RPAP members and U.S. ATLAS principals and Subsystem Managers. If necessary, additional other mechanisms may be employed as deemed necessary to exercise the oversight function. These can include special reviews or meetings of the U.S. ATLAS Research Program.managed by the U.S. LHC Research Program Office (?) The RPAP reports to Laboratory management by means of verbal discussions and written reports following each major RPAP review. RPAP reports are transmitted to DOE and NSF and the U.S. LHC RPO. The ALD works with the RPM to address any problems uncovered in RPAP review.

3.4 U.S. Funding Agencies Make consistent with RPEP document

The Department of Energy (DOE) and the National Science Foundation (NSF) are the funding agencies for the U.S. participation in ATLAS pre-operations and operations Research Program?. As such the agencies determine the program scope, approve annual budgets, and monitor program implementation. The organization structure of DOE and NSF as it relates to the U.S. ATLAS Research Program is shown in Appendix 7.

The DOE has delegated responsibility for the U.S. ATLAS activities to the Office of Science, Office of High Energy Physics. The NSF has delegated responsibility for U.S. ATLAS activities to the Division of Physics, Elementary Particle Physics Programs.

The U.S. ATLAS Research Program receives substantial support from both DOE and NSF. Almost all the subsystems involve close collaboration between DOE and NSF supported groups. It is therefore essential that DOE and NSF oversight be closely coordinated. The DOE and NSF have established a U.S. LHC Joint Oversight Group (JOG) as the highest level of joint U.S. LHC Research Program management oversight. The JOG has responsibility to see that the U.S. LHC Research Program is effectively managed and executed so as to meet the commitments made to CERN under the International Agreement and its Protocols. The JOG provides programmatic guidance and direction for the U.S. LHC Research Program and coordinates DOE and NSF policy and procedures with respect to both. (non RPEP?) The JOG approves and oversees execution of the U.S. LHC Research Program and individual Management Plans, such as this RPMP.

All documents approved by JOG are subject to the rules and practices of each agency and the signed Agreements and Protocols.

U.S. LHC Research Program Office

The U.S. LHC Program Office is established to carry out the management functions set forth in the MOU, the U.S. LHC Construction Project Execution Plan, and the Management Plans associated with the U.S. LHC Research Program. The program office is staffed by Federal employees or IPA appointees assigned by the DOE and NSF. As the DOE has been designated “lead agency” for the U.S. LHC Program, the

U.S. LHC Program Manager that heads the program office will generally be a DOE employee. The U.S. Associate LHC Program Manager will generally be an NSF employee.

The U.S. LHC Program Office has the overall responsibility for day-to-day program management of the U.S. LHC Program. In this capacity, it reports directly to the JOG and acts as its executive arm. The office is responsible for development of appropriate Management Plans, and interfaces with the DOE) Office of High Energy Physics) Repeat! and the NSF (Division of Physics, which are the respective agency offices charged with the responsibility to oversee the U.S. LHC Program). The Program Manager and Associate Program Manager are responsible for the coordination between the agencies of the joint oversight activities described in the MOU and the U.S. LHC Research Program Management Plans. In particular, the Program Office will arrange for appropriate agency clearances of the management plans, and other documents as may be required, as well as the accomplishment of program reviews as charged by the JOG or as deemed necessary for effective program management. These reviews will be held at least annually. In addition, the Program Office will coordinate: interactions with the Congress in response to official inquiries, testimony, or discussion; initiatives in education; public outreach activities; and, release of public information. (?)

U.S. LHC Project Office Make consistent with RPEP document
The U.S. LHC Project Office is established to carry out the management functions set forth in the MOU, the U.S. LHC Construction Project Execution Plan, and the Project Management Plans for each of the U.S. LHC Construction Projects. The project office is staffed by Federal employees or IPA appointees assigned by the DOE and NSF. As the DOE has been designated "lead agency" for the U.S. LHC Program, the U.S. LHC Project Director (formerly called "Project Manager") that heads the U.S. LHC Project Office will generally be a DOE employee. The DOE Fermi Site? Office is the home of the U.S. LHC Project Office.

The Area Office Manager will delegate to the U.S. LHC Project Director the authority for day-to-day implementation and direction of the Research Program. The Fermi Site? Office Manager will provide support from Fermi Site? Office staff when necessary and appropriate. NSF personnel may be added to the U.S. LHC Project Office as appropriate. The U.S. LHC Project Office provides day-to-day project management and support for the U.S. LHC Construction Projects. The U.S. LHC Project Office receives guidance and direction from the U.S. LHC Program Office and serves as the day-to-day contact for the DOE and NSF on issues specific to each of the U.S. LHC Construction Projects. The U.S. LHC Project Office provides general assistance, support and coordination with the U.S. LHC Program Office on the planning and execution of the U.S. LHC research program.

3.5 Research Program Responsibilities

General responsibilities for the operation and upgrade of the detector components will be assigned through the traditional process of matching interests, capabilities, and resources of the members of the U.S. ATLAS Collaboration. These responsibilities are ? specified in the international Memorandum of Understanding (MOU) agreed to by all the funding agencies. U.S. institution-by-institution responsibilities will be detailed in Institutional Memoranda of Understanding (MOUs) executed by the Research Program Office with the individual U.S. institutions. Appendix 3 lists the U.S. institutions participating in the operations and upgrades of the U.S. ATLAS Research Program.

4 WORK BREAKDOWN STRUCTURE (WBS)

Project Management procedures, as described in Sections 4 to 7, will be applied to work on upgrades to the ATLAS detector and to other parts of the Research Program, as deemed useful and appropriate. In general, the work on pre-operations and M&O will follow from the detector components that the U.S. delivers to ATLAS. Although a detailed WBS will be prepared for pre-operations, M&O, upgrade R&D

and Physics and Computing, only any future Upgrades (Construction) following proposal and approval will use a traditional resource-loaded schedule and performance measures.

All work required for the successful conduct of the U.S. ATLAS Research Program will be organized into a Work Breakdown Structure. The WBS completely defines the scope of work, the deliverables, and is the basis for planning, cost and schedule estimates, and measurement of performance. The current WBS is given in Appendix 8, and will be expanded to a level sufficient to allow definition of individual tasks/elements for which costs can be estimated in an unambiguous manner?.

Cost estimates will be generated at the most detailed level of the WBS and summed to the top level to determine the total cost of the U.S. ATLAS Research Program. The WBS also provides a basis for resource-loaded* schedules with detailed durations assigned to each task in time. Interdependencies (project logic) will be defined between the WBS elements to generate detailed schedules that phase each task. The integration of schedule and costs provides a time-phased budget that can be used for measuring performance.

*I hate this term. Do we have to keep it in an intelligent document? What does it mean? Awful jargon!

To take into account uncertainties in cost estimates, contingency based on a risk analysis for each WBS element are added to the costs. The result is a 25% Management Reserve created to avoid the risk of overruns on these tasks.

5 SCHEDULES AND MILESTONES OF THE RESEARCH PROGRAM

Schedules for the U.S. ATLAS Research Program will be generated at three levels of detail based on the WBS. For Upgrades (WBS 4), detailed, intermediate and summary schedules will be generated using commercially-available project management software. Schedules for Operations will be generated in a simpler way to track work on M&O (WBS 3), as needed. Specific performance measures for Computing (WBS 2) are related to the level of effort for Software and the fraction of hardware costs of any facility.

5.1 Schedules

The detailed schedules will be generated by each Subsystem Manager to show milestones and resources for all efforts associated with work required to be provided for that subsystem. Activity duration, start and completion dates are coordinated with ATLAS schedule activities to ensure that the completion date for ATLAS is maintained. These activities are logically interconnected to form networks with all other elements that comprise the subsystem. These schedules are maintained by the Subsystem Managers and are kept consistent with the current cost estimate. The detailed schedules from each subsystem will be used to generate both the intermediate and summary schedules that are used for estimating the baseline schedule and costs. (?)

5.2 Summary Schedule

Key U.S. ATLAS milestones and other selected milestones from the baseline schedules are incorporated into a summary milestone schedule that is used for reporting purposes. This summary schedule addresses all subsystems and provides an overview of work in process. A summary logic network is also maintained to show critical paths. These schedules are updated on the basis of status inputs to the intermediate schedules, and used for periodic reporting. Is this all for U.S. ATLAS or does international ATLAS come in? Clarify.

6 COST ESTIMATES

6.1 Cost Objectives

Cost estimates will be prepared by the Managers using the WBS. All estimates will include all labor, materials and supplies (M&S) and travel required to complete the work comprising the U.S. ATLAS Research Program and will be specified in MOUs and yearly updates. A Management Reserve will be controlled by the Research Program Manager. Escalation will be based on the latest DOE guidance.

7 MANAGEMENT SYSTEM

This sounds more like the Project (construction) document? Not bad, but too much detail?

The U.S. ATLAS Research Program Management System (RPMS) incorporates three primary elements:

? Baseline Development - Defining Research Program scope and establishing the necessary cost and schedule baselines and work execution plans.

? Research Program Performance - Research Program status monitoring, reporting and performance analysis.

? Change Control - Management of Research Program baselines and contingency funds.

7.1 Prioritization of Different Parts of the Research Program

Acting on the basis of the yearly funding guidance from the U.S. LHC RPO, the Research Program Manager sets target budgets for each Level 2 component of the Research Program including M&O, Physics and Computing, and Upgrade R&D. Priority may have to be placed on one of these areas, depending on the level of the guidance and the needs of the experiment. Prioritization by the RPM will established in consultation with the Executive Committee.

7.2 Baseline Development

The cost and schedule baseline and the hierarchical relationships will be defined in a Work Breakdown Structure. Detailed cost estimates will be developed using standard estimating methodologies, and integrated with the definition of scope. For the M&O, the scope will be defined by U.S. responsibilities for each subsystem.

7.3 Performance

The management of funds will be guided by the level of support from DOE and NSF to the individual institutions in accordance with the baseline estimate and the broad needs of the Research Program. Here I don't follow. What does this mean? Within ATLAS? Funding is planned to occur as much as twice each year. Work authorization is provided for each U.S. institution through an Institutional MOU process that defines the full scope of work, including deliverables, and establishes the funding for the fiscal year. An yearly amendment to the Institutional MOU specifies the funding ceiling to each institution and each subsystem. Standard accounting procedures are used to collect costs for completed work and to define the funds available for the remainder of the fiscal year. No performance analysis will be performed for M&O, Physics and Computing or Upgrade R&D. A status report is to be issued each quarter, as shown in Table 7-3 (?).

7.3.1 Reporting

I. Technical Progress Refer to 7-1, 7-2 first

The individual responsible for each activity at each institution will report in writing the progress in each quarter. Each item should refer to the appropriate Level 3 WBS element and any completed milestones. This is due on the 5th of the month following the end of the quarter and is sent to be sent to the Subsystem Manager. Each level 2 Manager collates the input and sends it to the Research Program Manager by the

15th of the month. The Executive Manager for Physics and Computing writes a summary of the activities for those areas. The Deputy? Research Program Manager collates the text, writes an overall assessment and summary, and finishes the report by the 25th of the month (?) following the end of the quarter.

II. Costs
Each institution reports on each active Level 5 item. Reports are provided to the Program Office via a Web interface.

III. Performance

Too detailed for this document? OK, but not needed. Consistency with RPEP?

If there is an approved Upgrade Construction Project, each Subsystem Upgrade Manager will provide an estimate of the progress of each WBS Level 5 item by the 15th of the month following the end of the quarter. This is to be accomplished by updating EXCEL spreadsheets. These reports of schedule and cost variance can be transmitted to any higher level. There are schedule-status and turn-around documents that are standardized for schedules and performance measurements at Level 5 of the WBS. Reporting processes are employed to provide timely, accurate periodic progress reports that provide analysis, evaluation, and corrective action of work scope, schedule, and cost performance relative to the approved baseline.

7.3.2 Procurements

The U.S. ATLAS Research Program has defined procurements over $100k as major and subject to RPO who? tracking and control. U.S. ATLAS will work closely with the ATLAS Technical or Operations Coordinator in making sure that proper design reviews are conducted. The U.S. ATLAS Research Program Manager must approve major procurements and the RPM or Deputy RPM must be notified at least two days prior to any award of a contract.

7.4 Management of Change

Management Reserve funds are held by the U.S. ATLAS Research Program Manager.

The Change Control Process outlined in Table 7-1 is used to control changes to the Technical, Cost and Schedule Baselines. The membership of the Change Control Board (CCB) consists of the following:

Chair - Research Program Manager
Deputy Research Program Manager
Subsystem Managers
Physics and Computing Managers
Research Program Office (See Section 9.0)

Baseline Change Proposals (BCP) for changes to the Technical, Scope, Cost or Schedule are referred to the CCB. The following changes are required to be submitted for consideration by the CCB:

Any change that affects the interaction between different detector systems, the interaction region, or hall safety issues. Such changes also require the concurrence of international ATLAS.

Any change that alters the performance, the cost or schedule baselines beyond established thresholds of budgets, as defined in Agency Reviews: Computing, normally in January, and M&O Evaluation in February.

Any change to the budget of the Management Reserve.

The CCB considers the change and its impact, consulting, when necessary, with appropriate outside technical experts. Thresholds for the approval of changes to the technical scope, cost and schedule are summarized in Table 7-2. After the CCB recommends action on the BCP, the RPM approves or rejects the BCP. The BNL Associate Laboratory Director is also required to approve all BCPs involving a cost or schedule change. The ATLAS Spokesperson must be notified of and approve all changes affecting? (Surely not not all changes go to Jenni?). Upon approval, the change is incorporated into the baseline. An audit trail is provided for each change.

See RPEP for notification of U.S. LHC RPO.

Table 7-1: U.S. ATLAS Change Control Process

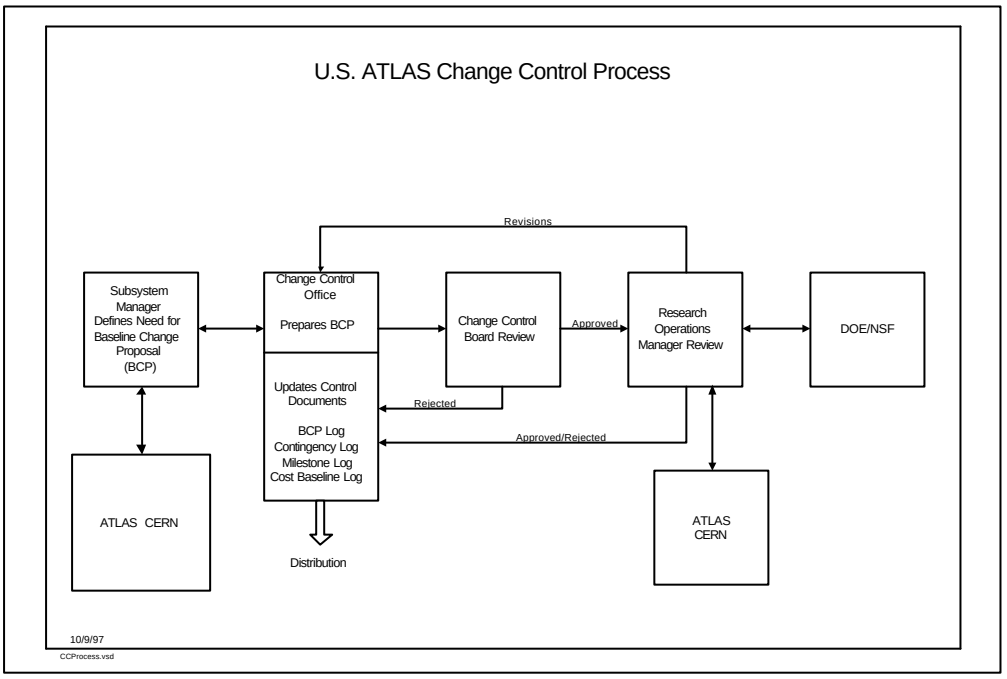


Table 7-2: U.S. ATLAS Change Control Thresholds

	Level 3 U.S. ATLAS Research Program Manager and BNL Associate Laboratory Director
Technical Cost	Changes in scope. Changes to the cost baseline at WBS Level 2 compared to the previous agency preview.
Schedule	Greater than a 3 month change in a high level milestone.

7.5 Meetings with DOE and NSF

There are regular coordination meetings between the DOE/NSF U.S. LHC Research Program Management, the Joint Oversight Group, the ALD, and U.S. ATLAS Research Program Management personnel for problem identification, discussion of issues, and development of solutions. Written reports on the status of the U.S. ATLAS Research Program are submitted regularly, as specified in Table 7-3. See RPEP.

Table 7-3: Periodic Reports to DOE and NSF

REPORT	FREQUENCY	SOURCE	RECIPIENTS
Research Program Status	Quarterly	U.S. ATLAS Collaboration	DOE/NSF Program Office and Staff BNL Associate Laboratory Director RPAP, Executive Committee Institutional Representatives

7.6 Periodic Reviews

Peer reviews, both internal and external to the Collaboration, provide a critical perspective and important means of validating designs, plans, concepts, and progress. The Research Program Advisory Panel, appointed by the BNL Associate Laboratory Director provides a major mechanism for review. The U.S. LHC RPO conducts separate reviews of U.S. ATLAS pre-operations, operations activities and plans, and software and computing activities. In addition, the RPM conducts internal reviews to provide technical assessments of U.S. ATLAS activities, as deemed appropriate. Normally, reports from reviews are made available to members of the U.S. ATLAS Collaboration. However, if a particular report contains material that is too sensitive for general dissemination, it may be deleted and replaced by a summary for the benefit of the Collaboration.

In addition to the day-to-day interaction of the line managers there are major mechanisms for periodic formal assessment of the U.S. ATLAS Research Program. These mechanisms include meetings of the JOG or periodic peer-reviews and evaluations conducted at the request of the U.S. LHC Research Program Office, the host/lead laboratory and through any internal reviews conducted by the laboratory and university program managers.

In particular, regular reviews are conducted by the U.S. LHC RPO of both the U.S. LHC Detector Maintenance & Operations (M&O) and the U.S. LHC Software & Computing (S&C) elements. (first mention of S&C!) A U.S. LHC Detector M&O Evaluation Group (MEG) has been established with members having expertise in maintenance and operation of particle physics detectors. The MEG assesses the U.S. ATLAS and U.S. CMS Collaborations' proposals concerning the M&O scope and costs, and reports to the U.S. LHC RPO. Similarly, the U.S. LHC S&C efforts of U.S. CMS and U.S. ATLAS are reviewed annually by a committee of computing experts. The annual review is augmented by periodic reviews.

8 SUPPORTING FUNCTIONS

8.1 Quality Assurance

The overall ATLAS Management has established a Quality Assurance Plan (QAP) at CERN to assure that the detector systems will achieve the technical requirements and reliability needed for operation at the

LHC. A general description of the ATLAS QAP is given in ATLAS Document ATL-GE-CERN-QAP-0101.00. It assigns overall responsibility for this task to the ATLAS Spokesperson, assisted by the Technical Coordinator. Furthermore, each ATLAS System Leader (SL) is assigned the responsibility of implementing a Quality Assurance Plan relevant to that subsystem. Each SL is expected to designate a Quality Assurance Representative (QAR) with the authority and organizational freedom to identify potential and actual problems that could result in a degradation of quality, to recommend corrective actions, and to verify implementation of solutions.

Quality Assurance is an integral part of the U.S. ATLAS Research Program. The U.S. ATLAS Research Program Manager has overall responsibility for quality assurance. In general, the U.S. ATLAS Subsystem Managers have the quality assurance responsibilities for their subsystems including the following aspects of quality control:

- Identification of those areas, concepts and components that require in-depth studies, prototyping and testing
- Incorporation of necessary acceptance tests into plans and specifications.
- Verification of system performance.
- Documentation of procedures and test results for fabrication and procurement phases.

8.2 Environment, Safety & Health

International ATLAS Management has established an ES&H program at CERN to assure that the delivered detector systems conform to safety standards in force at CERN at and LHC operations. The U.S. ATLAS Research Program Manager has overall responsibility for ensuring that managers of the systems comprising part of the U.S. ATLAS Research Program work with the ATLAS Group Leader in Matters of Safety (GLIMOS) and satisfy all ATLAS-specified safety regulations and that all institutional ES&H requirements are fully met for U.S. ATLAS work performed in those institutions. In general, the U.S. ATLAS Subsystem Managers have responsibility for ES&H issues within their own subsystems including the following:

- Reviewing designs, procedures and practices to identify ES&H potential hazards ensuring and ensure potential hazards are adequately addressed.
- Assuring that ES&H requirements are met and procedures followed correctly during operation and maintenance activities.

8.3 Property Management

All property will be managed in accordance with established practices of the participating U.S. ATLAS institutions. Property transferred to CERN will be subject to provisions of the International Agreement.

9 ORGANIZATION OF THE U.S. ATLAS RESEARCH PROGRAM OFFICE (RPO)

The U.S. ATLAS Research Program Office is located at the Host Laboratory, Brookhaven National Laboratory and at Columbia University. The RPO provides technical coordination, financial (pays him?) support to the Research Program Manager. The Research Program Manager or Deputy provides direction to RPO staff and manages the day-to-day operations of the RPO. The RPO will be staffed to coordinate administrative and technical activities of U.S. ATLAS including:

- Annual preparation of budget,
- Financial and Technical reporting,
- Development of Proposals for Upgrade.of the detector.

The RPO staff will include a Planning Manager and an engineer. The Operations Office will have the responsibility of reviewing and issuing contracts in support of Research Operations. This includes funding specific activities at collaborating U.S. institutions.

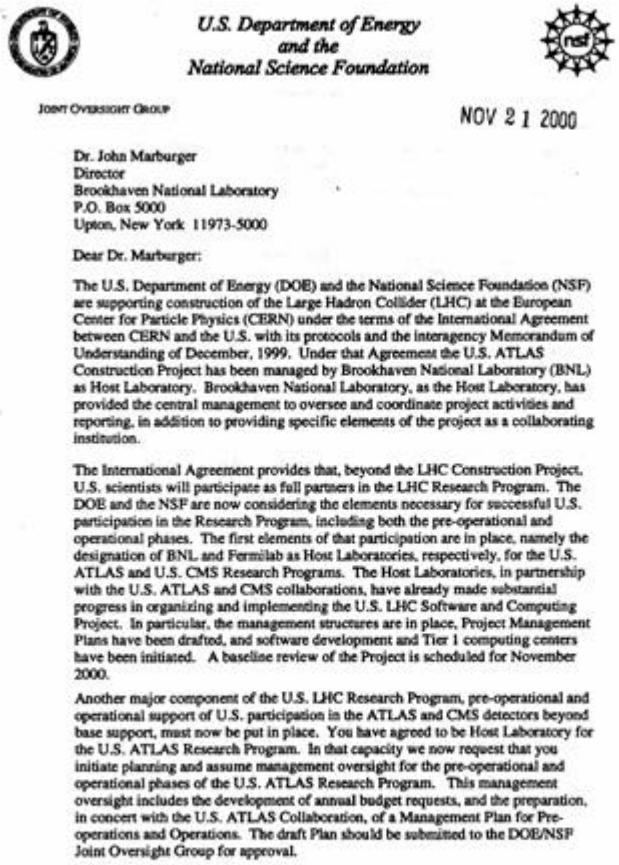
10 REVIEW AND MODIFICATION OF THIS RESEARCH PROGRAM MANAGEMENT PLAN

After its adoption, this Research Program Management Plan will be reviewed periodically by the Research Program Manager and the other Managers as part of the preparation for reviews by the RPAP. Proposals for its modification may be initiated by the RPM, the Executive Committee, the BNL Associate Laboratory Director, and the funding agencies. Significant changes to the plan require approval of the U.S. LHC RPO and Joint Oversight Group. Modifications of the Research Program Management Plan will require approval of the RPM, the Associate Laboratory Director, the U.S. LHC Program Manager, and the Joint Oversight Group.

11 REFERENCES

1. DOE/NSF MOU between DOE and NSF concerning U.S. Participation in the LHC Program, December, 1999 (U.S. ATLAS 99-20).
2. U.S. LHC Construction (?) Project Execution Plan, Rev. 1, October, 2002.

Appendix 1: Letter to Dr. John Marburger from the Joint Oversight Group Fall, 2000



U.S. Department of Energy and the National Science Foundation

JOINT OVERSIGHT GROUP

NOV 21 2000

Dr. John Marburger
Director
Brookhaven National Laboratory
P.O. Box 5000
Upton, New York 11973-5000

Dear Dr. Marburger:

The U.S. Department of Energy (DOE) and the National Science Foundation (NSF) are supporting construction of the Large Hadron Collider (LHC) at the European Center for Particle Physics (CERN) under the terms of the International Agreement between CERN and the U.S. with its protocols and the interagency Memorandum of Understanding of December, 1999. Under that Agreement the U.S. ATLAS Construction Project has been managed by Brookhaven National Laboratory (BNL) as Host Laboratory. Brookhaven National Laboratory, as the Host Laboratory, has provided the central management to oversee and coordinate project activities and reporting, in addition to providing specific elements of the project as a collaborating institution.

The International Agreement provides that, beyond the LHC Construction Project, U.S. scientists will participate as full partners in the LHC Research Program. The DOE and the NSF are now considering the elements necessary for successful U.S. participation in the Research Program, including both the pre-operational and operational phases. The first elements of that participation are in place, namely the designation of BNL and Fermilab as Host Laboratories, respectively, for the U.S. ATLAS and U.S. CMS Research Programs. The Host Laboratories, in partnership with the U.S. ATLAS and CMS collaborations, have already made substantial progress in organizing and implementing the U.S. LHC Software and Computing Project. In particular, the management structures are in place, Project Management Plans have been drafted, and software development and Tier 1 computing centers have been initiated. A baseline review of the Project is scheduled for November 2000.

Another major component of the U.S. LHC Research Program, pre-operational and operational support of U.S. participation in the ATLAS and CMS detectors beyond base support, must now be put in place. You have agreed to be Host Laboratory for the U.S. ATLAS Research Program. In that capacity we now request that you initiate planning and assume management oversight for the pre-operational and operational phases of the U.S. ATLAS Research Program. This management oversight includes the development of annual budget requests, and the preparation, in concert with the U.S. ATLAS Collaboration, of a Management Plan for Pre-operations and Operations. The draft Plan should be submitted to the DOE/NSF Joint Oversight Group for approval.

Plans to be developed with the appropriate leadership at CERN could be expected to include:

- Participation in detector operations and data monitoring;
- Support for monitoring and maintenance of U.S.-provided subsystems;
- Establishment of an environment at BNL including a virtual control room to facilitate U.S.-based ATLAS physics analysis; and,
- Continuing R&D, with possible fabrication, of upgrades to enhance the physics productivity of the detector.

This document further specifies the responsibilities agreed upon in the Host Laboratory letter of August 1999. Funding will be identified to carry out the U.S. ATLAS Research Program, including both U.S. Software and Computing, and Pre-operations and Operations. We expect that the methods for allocating the designated funding will be similar to those used for the U.S. ATLAS Construction Project. The methods of allocation should be specified in the Project Management Plan.

Sincerely,

John R. O'Fallon
Co-chair
U.S. LHC Joint Oversight Group
Department of Energy

John W. Lightbody, Jr.
Co-chair
U.S. LHC Joint Oversight Group
National Science Foundation

****

On behalf of Brookhaven National Laboratory, I accept this further specification of the Host Laboratory role for the U.S. ATLAS Research Program.

John Marburger
Director
Brookhaven National Laboratory

Appendix 2: Le tter to Dr. Praveen Chaudhari from the Joint Oversight Group. November 7, 2003

Official 2003-2

U.S. Department of Energy
and the
National Science Foundation

November 7, 2003

Joint Oversight Group

Dr. Praveen Chaudhari
Director
Brookhaven National Laboratory
Building 460
Upton, NY 11973-5000

Dear Dr. Chaudhari:

At its recent meeting the Joint Oversight Group (JOG) decided to augment the management structure for the U.S. ATLAS and U.S. CMS Programs by creating a Deputy Program Manager position for both programs. This letter defines a process for making this a reality.

This management structure is consistent with the original expectations of line management through the Host Laboratories and the Program Managers appointed by the Host Laboratories. Program Management responsibilities include the on-going detector construction projects and the elements of the research program: detector Maintenance & Operations (M&O) and Software & Computing (S&C). The addition of a Deputy Program Manager position is in direct response to this broad scope of responsibility and the desire to provide additional opportunities for empowering universities in leadership positions. Regarding the Program Manager and Deputy Program Manager, it is anticipated that one be from a National Laboratory and the other from a U.S. university. It is expected that in each U.S. detector program either the Program Manager or the Deputy Program Manager, whichever is from a university, will also serve as the Principal Investigator for the NSF Cooperative Agreement covering the research program funding. The NSF Principal Investigators will be responsible for ensuring that NSF research program funds are allocated in accordance with the decisions made by the Program Managers.

When identifying appropriate candidates for the Program or Deputy Program Manager positions it is expected that the Host Laboratories and/or Program Managers will solicit active involvement, support and concurrence by the U.S. collaborations and communicate progress along the way to the agencies. This should be followed by requests from the Host Laboratories for concurrence by the JOG and finally appointments by the Host Laboratories. Management documents should be revised to reflect this new structure along with descriptions of the roles and responsibilities of the Program Managers and Deputy Program Managers. We expect the Host Laboratories to provide primary oversight on issues that may arise with the implementation of this new management structure.

Implementing this Program/Deputy Program Management structure is an important step toward meeting the challenge and needs of the rapidly expanding U.S. LHC Research Program, overall. It is hoped that this structure also will reflect the diversity of the National Laboratory and University communities, as well as the Agencies, involved in these detector collaborations.

Sincerely,

John R. O'Fallon
Co-Chair
U.S. LHC Joint Oversight Group
Department of Energy

John W. Lightbody, Jr.
Co-Chair
U.S. LHC Joint Oversight Group
National Science Foundation

Cc:
Robin Staffin, SC-20
John R. O'Fallon, SC-20
Jack Lightbody, NSF
Aesook Byon-Wagner, SC-20
Moishe Pripstein, SC-20
Marv Goldberg, NSF
Jim Whitmore, NSF
Pepin Carolan, FAO
Thomas Kirk, BNL
William Willis, Columbia University

Appendix 3: U.S. ATLAS Participating Institutions

? DOE/NSF ? all

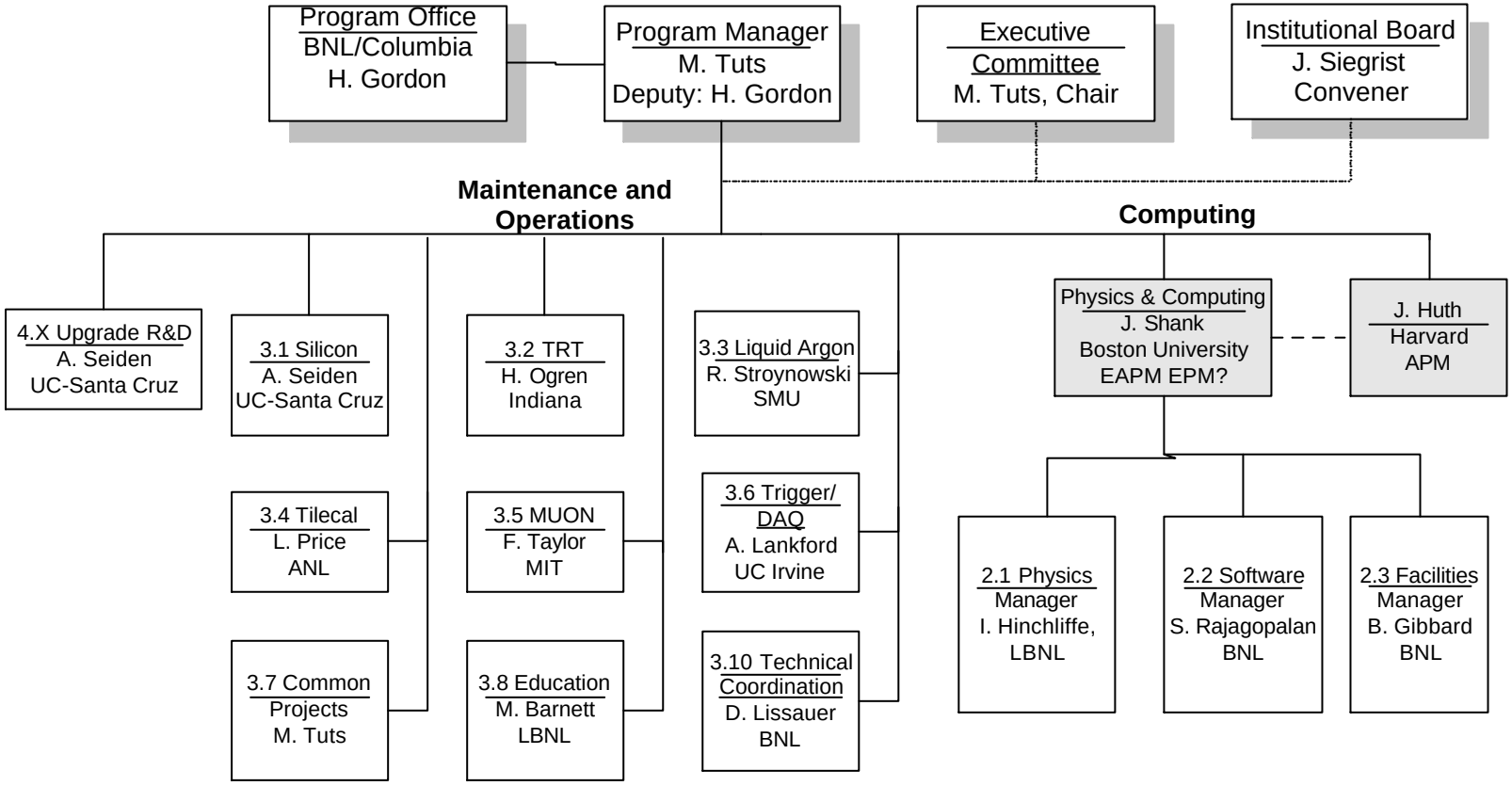
Argonne National Laboratory
University of Arizona (DOE)
Boston University (DOE)
Brandeis University (DOE/NSF)
Brookhaven National Laboratory (DOE)
University of California, Berkeley/Lawrence Berkeley National Laboratory (DOE)
University of California, Irvine (DOE/NSF)
University of California, Santa Cruz (DOE/NSF)
University of Chicago (NSF)
Columbia University (Nevis Laboratory) (NSF)
Duke University (DOE)
Hampton University (NSF)
Harvard University (DOE/NSF)
University of Illinois at Urbana-Champaign (DOE)
Indiana University (DOE)
Iowa State University (DOE)
U. of Massachusetts, Amherst (DOE)
Massachusetts Institute of Technology (DOE)
University of Michigan (DOE)
Michigan State University (NSF)
University of New Mexico (DOE)
State University of New York at Albany (DOE)
State University of New York at Stony Brook (DOE/NSF)
Ohio State University (DOE)
University of Oklahoma/Langston University (DOE)
University of Pennsylvania (DOE)
University of Pittsburgh (DOE/NSF)
University of Rochester (DOE/NSF)
Southern Methodist University (DOE)
University of Texas at Arlington (DOE/NSF)
Tufts University (DOE)
University of Washington (NSF)
University of Wisconsin, Madison (DOE)
Yale University (DOE)

Appendix 4 – Current Institutional Responsibilities

Subsystem	Institutions
Silicon	UC-Berkeley/LBNL, UC-Irvine, UC-Santa Cruz, Iowa State New Mexico, Ohio State, Oklahoma, SUNY-Albany, Wisconsin
TRT	Duke, Hampton, Indiana, Pennsylvania, Yale
Liquid Argon Calorimeter	Arizona, BNL, Columbia, Pittsburgh, Rochester, Southern Methodist U., SUNY-Stony Brook
Tile Calorimeter	ANL, Chicago, Illinois at Champaign-Urbana, Michigan State, UT at Arlington
Muon Spectrometer	Arizona, Boston, BNL, Brandeis, Harvard, MIT, Michigan SUNY-Stony Brook, Tufts, UC-Irvine, Washington
Trigger and DAQ	ANL, UC-Irvine, Michigan State, Wisconsin
Software	Arizona, ANL, Boston, BNL, Chicago, Harvard, Indiana, LBNL, Pittsburgh, UT at Arlington
Facilities	Boston, BNL, Chicago, Indiana

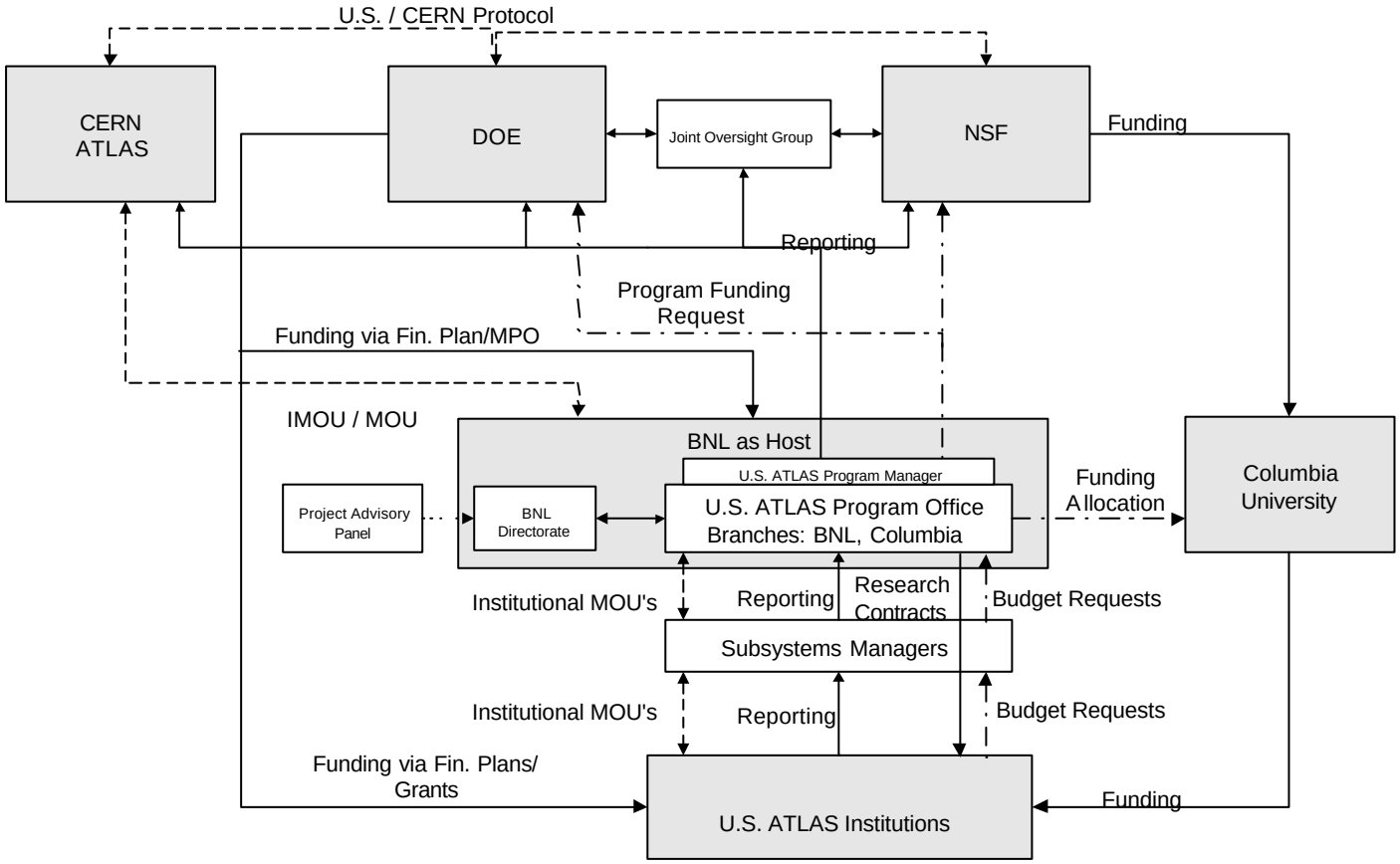
Appendix 5

U.S. ATLAS Research Program Organization as of Sept. 1, 2004



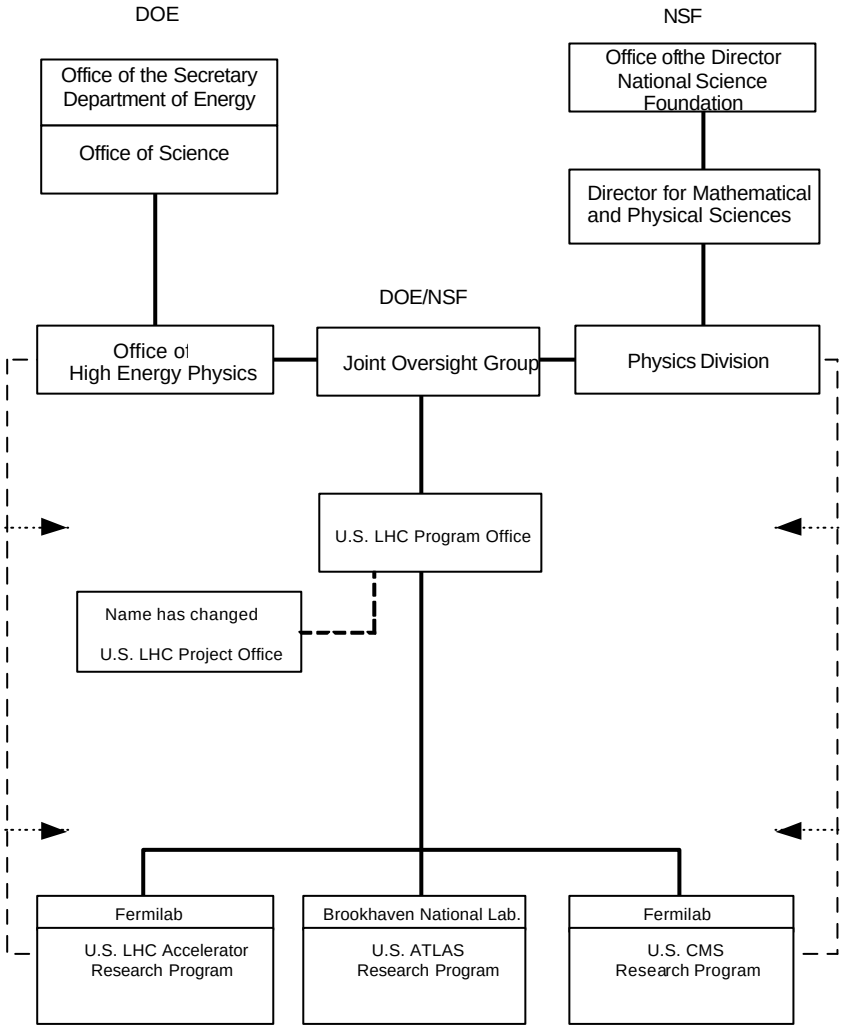
Appendix 6: MOU, Funding and Reporting Process

What do different kinds of lines mean?



Appendix 7: DOE-NSF-U.S. LHC Research Program Organization

U.S. LHC Construction Project Organization



APPENDIX 8: WBS

WBS #	Description
2.1	Physics
2.2	Software
2.2.1	Coordination
2.2.1.1	Software Project Coordination
2.2.1.2	Data Management Coordination
2.2.2	Core Services
2.2.2.1	Framework
2.2.2.2	EDM Infrastructure
2.2.2.3	Detector Description
2.2.2.4	Graphics
2.2.2.5	Analysis Tools
2.2.2.6	Grid Integration
2.2.3	Database
2.2.3.1	Database Services and Servers
2.2.3.2	Common Data Mgmt Software
2.2.3.3	Event Store
2.2.3.4	Non-event Data Management
2.2.3.5	Collections, Catalogs, Metadata
2.2.4	Application Software
2.2.4.1	Simulation
2.2.4.2	Subsystem Reconstruction
2.2.4.3	Combined Reconstruction
2.2.4.4	Analysis
2.2.4.5	Trigger
2.2.4.6	Combined Testbeam Software

2.2.5	Infrastructure Support
2.2.6	Analysis Support Group
2.3	Computing Facilities
2.3.1	Tier 1 Facilities
2.3.1.1	Management/Administration
2.3.1.2	Tier 1 Fabric Infrastructure
2.3.1.3	Tier 1 Linux Systems
2.3.1.4	Tier 1 Storage Systems
2.3.1.5	Tier 1 Wide Area Services
2.3.1.6	Tier 1 Operations
2.3.2	Tier 2 Facilities
2.3.2.1	Tier 2 A, B, C Facilities
2.3.3	Wide Area Network
2.3.4	Grid Tools and Services
2.3.4.1	Grid Infrastructure
2.3.4.2	Workflow Services
2.3.4.3	Data Services
2.3.4.4	Monitoring Services
2.3.4.5	Production Frameworks
2.3.4.6	Analysis Frameworks
2.3.5	Grid Production
2.3.5.1	Software Acceptance
2.3.5.2	Deployment of Software Services
2.3.5.3	Validation and Hardening
2.3.5.4	Operations
2.9	Program Support
2.9.1	Program Support - Nevis

3.0	U.S. ATLAS M&O Est.
3.1	Silicon
3.1.1	Pixels
3.1.1.1	Pre-operations
3.1.1.2	Operations
3.1.1.3	Maintenance
3.1.2	SCT
3.1.2.1	Pre-Operations
3.1.2.2	Operations
3.1.2.3	Maintenance
3.1.3	RODs
3.1.3.1	Pre-operations
3.1.3.2	Operations
3.1.3.3	Maintenance
3.1.4	Common Silicon/ID
3.2	TRT
3.2.1	TRT Subsystem
3.2.1.1	TRT Pre-operations
3.2.1.2	TRT Operations
3.2.1.3	TRT Maintenance
3.2.2	Common TRT/ID
3.2.2.1	Pre-operations
3.2.2.2	Maintenance and Operations (IU)
3.2.2.3	Maintenance and Operations (Nevis)
3.3	Liquid Argon
3.3.1	Mechanical LAr M&O Estimate
3.3.1.1	Pre-operations and Commissioning
3.3.1.2	Operations
3.3.1.3	Maintenance
3.3.2	Electrical LAr M&O Estimate
3.3.2.1	Pre-operations and Commissioning
3.3.2.2	Operations

3.3.2.3	Maintenance
3.3.3	Beam Test
3.3.3.1	FCAL Hadronic Tail Measurement
3.3.3.2	Test Beam – Optical Links
3.3.3.3	Front-end Readout Commissioning
3.3.3.4	Beam Test Equipment Modification
3.3.4	CERN Living Expenses
3.3.5	Common LAr
3.4	TileCal System
3.4.1	Tile Cal – Specific Costs
3.4.1.1	Pre-operations
3.4.1.2	Operations (Beam On)
3.4.1.3	Maintenance (Beam Off)
3.4.2	Calibration and Monitoring
3.4.2.1	Pre-operations
3.4.2.2	Operations (Beam On)
3.4.2.3	Maintenance (Beam Off)
3.4.3	Common Costs
3.5	Muon Subsystem
3.5.1	MDT Pre-operations, Operations and Maintenance
3.5.1.1	MDT Pre-operations
3.5.1.2	MDT Operations (Beam On)
3.5.1.3	MDT Maintenance (Beam Off)
3.5.1.4	MDT Spares – Mechanical and Elect
3.5.2	CSC Pre-operations, Operation and Maintenance
3.5.2.1	CSC Pre-operations
3.5.2.2	CSC Operations (Beam On)
3.5.2.3	CSC Maintenance (Beam Off)
3.5.2.4	CSC Spares – Mechanical and Elec
3.5.3	Alignment System Pre-operations, M&O
3.5.3.1	Alignment System Pre-operations

3.5.3.2	Alignment System Operation (Beam On)
3.5.3.3	Alignment System Maintenance (Beam Off)
3.5.4	Muon Endcap Common Costs
3.5.4.1	Engineering Coordination of Endcap
3.5.4.2	Muon Endcap Common Cost Operation
3.5.5	Monitoring and Calibration
3.5.5.1	Monitoring and Calibration Beam Operation
3.5.5.2	Muon Test Beams
3.6	Trigger/DAQ
3.6.1	Pre-operations
3.6.1.1	Supervisor RoI Builder
3.6.1.2	Communications and Travel
3.6.1.3	Programming Support
3.6.1.4	Equipment
3.6.2	Operations
3.6.2.1	Supervisor RoI Builder
3.6.2.2	Communications and Travel
3.6.2.3	Programming Support
3.6.2.4	Test Facilities
3.6.3	CERN Common Costs
3.7	Common ATLAS
3.8	Education/Outreach
3.9	Program Management
3.9.1	BNL Program Management
3.9.2	Nevis Program Management
3.9.3	Michigan (?) Program Management Work
3.10	Technical Coordination
4.0	Upgrade R&D